IS 14662 (1999): Manipulating Industrial Robots - Vocabulary [PGD 18: Industrial and Production Automation Systems and Robotics]

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भारतीय मानक

औद्योगिक रोबॉट संचालन – शब्दावली

Indian Standard

MANIPULATING INDUSTRIAL ROBOTS — VOCABULARY

ICS 25.040.30

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Price Group 6

Industrial and Production Automation Systems and Robotics Sectional Committee, PE 18

NATIONAL FOREWORD

This Indian Standard which is identical with ISO 8373 :1994 'Manipulating industrial robots —Vocabulary' issued by the International Organization for Standardization (ISO) was adopted by the Bureau of Indian Standards on the recommendations of the Industrial and Production Automation Systems and Robotics Sectional Committee and approval of the Production Engineering Division Council.

The text of the ISO Standard has been approved as suitable for publication as Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker in the international standard while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

For convenience of reference, this vocabulary is supplemented by an alphabetical index of all the terms, each term being identified by its clause number in the text. This will help the reader to refer back to the main vocabulary and its definition.

Indian Standard

MANIPULATING INDUSTRIAL ROBOTS — VOCABULARY

1 Scope

This International Standard defines terms relevant to manipulating industrial robots operated in manufacturing environment.

2 General terms

2.1
manipulator
machine, the mechanism of which usually consists of a series of segments jointed or sliding relative to one another, for the purpose of grasping and/or moving objects (pieces or tools) usually in several **degrees of freedom** (4.4)

NOTE — It may be controlled by an **operator** (2.16), a programmable electronic controller, or any logic system (for example cam device, wired).

2.2
fixed sequence manipulator
manipulator (2.1) which performs each step of a given operation according to a predetermined motion pattern which cannot be changed without **physical alteration** (2.3)

2.3
physical alteration
alteration of the mechanical structure or control system.

NOTE — Does not include changing programming cassettes, ROMs. etc.

2.4
reprogrammable
whose programmed motions or auxiliary functions may be changed without **physical alteration** (2.3)

2.5
multipurpose
capable of being adapted to a different application with **physical alteration** (2.3)

2.6
manipulating industrial robot
robot
automatically controlled, **reprogrammable** (2.4), **multipurpose** (2.5), **manipulator** (2.1) programmable in three or more **axes** (4.3) which may be either fixed in place or mobile for use in industrial automation applications

NOTE — The robot includes

— the manipulator (including actuators);
— the control system (hardware and software).

2.7
control system
set of logic control and power functions which allows to monitor and control the mechanical structure of the robot and to communicate with the environment (equipment and users)

2.8
playback robot
record playback robot
robot (2.6) that can repeat a **task program** (5.1.1) which is entered through **teach programming** (5.2.3)

2.9
off-line programmable robot
robot (2.6) that can perform a **task program** (5.1.1) entered through **off-line programming** (5.2.4) and such that the knowledge of the kinematics of the robot is enough to carry out the required performances

2.10
sequenced robot
robot (2.6) having a **control system** (2.7) in which the state of machine movements occurs axis by axis in a desired order, the completion of one movement initiating the next

2.11
trajectory operated robot
robot (2.6), which performs a controlled procedure whereby three or more controlled axis motions operate in accordance with instructions that specify the required time-based **trajectory** (4.6) to the next required **pose** (4.5) (normally achieved through interpolation)

NOTE — The velocity is usually varied for all axis motions so that the desired trajectory is generated.

2.12
adaptive robot
robot (2.6) having sensory control, adaptive control, or learning control functions

2.13
mobile robot
robot (2.6) which carries all of the means needed for its monitoring and movement (power, control, driving)

2.14
robot system
system comprising

- **robot** (2.6);
- **end effector(s)** (3.11);
- any equipment. devices, or sensors required for the robot to perform its task;
- any communication interface that is operating and monitoring the robot, equipment, or sensors, as far as these peripheral devices are supervised by the robot control system

2.15
robotics
practice of designing, building, and applying **robots** (2.6)

2.16
operator
person designated to start, monitor, and stop the intended operation of a **robot** (2.6) or **robot system** (2.14)

2.17
programmer
person designated to prepare the **task program** (5.1.1)

NOTE — Different ways of programming are defined in 5.2.

2.18
installation
operation consisting of installing the **robot** (2.6) on its site, connecting it to its supply and drive powers

2.19
commissioning
process of setting up, checking of the **robot system** (2.14) and the verification of the robot functions following **installation** (2.18)

3 Mechanical structure

3.1
machine actuator
power mechanism used to effect motion of the **robot** (2.6)

EXAMPLE — A motor which converts electrical, hydraulic, or pneumatic energy to effect motion of the robot.

3.2
arm
primary axes
interconnected set of **links** (3.6) and powered joints composing links of longitudinal shape which positions the **wrist** (3.3)

3.3
wrist
secondary axes
interconnected set of **links** (3.6) and powered joints between the **arm** (3.2) and **end effector** (3.11) which supports, positions and orients the end effector

3.4
articulated structure
set of **links** (3.6) and joints which constitutes the arm (3.2) and the **wrist** (3.3)

3.5
configuration
set of joint displacements values, equal in number to the number of **primary axes** (3.2), that completely determine the shape of the **arm** (3.2) at any time

3.6
link
rigid body which maintains a fixed relationship between joints

3.7 Joints

3.7.1
prismatic joint
sliding joint
assembly between two **links** (3.6) enabling one to have a linear motion relative to the other

3.7.2
rotary joint
revolute joint
assembly connecting two **links** (3.6) which

enables one to rotate relative to the other about a fixed axis.

3.7.3
distributed joint
cylindrical joint
assembly between two **links** (3.6) which enables one to translate and/or rotate relative to the other about an axis linked to the translation

3.7.4
spherical joint
assembly between two **links** (3.6) which enables one to pivot relative to the other about a fixed point in three **degrees of freedom** (4.4)

3.8
base
platform or structure to which the origin of the first **link** (3.6) of the **articulated structure** (3.4) is attached

3.9
base mounting surface
connection surface between the **robot** (2.6) and its supporting structure

3.10
mechanical interface
mounting surface at the end of the **articulated structure** (3.4) to which the **end effector** (3.11) is attached

3.11
end effector
device specifically designed for attachment to the **mechanical interface** (3.10) to enable the **robot** (2.6) to perform its task

EXAMPLES — Gripper, nutrunner, welding gun, spray gun.

3.12
end effector coupling device
flange at the end of the **articulated structure** (3.4) and locking devices or additional parts securing the **end effector** (3.11) to the end of the articulated structure

3.13
automatic end effector exchanger
coupling device between the **mechanical interface** (3.10) of the robot (2.6) and the **end effector** (3.11) enabling automatic exchange of end effectors

3.14
gripper
end effector (3.11) designed for seizing and holding

3.15 Types of mechanical structure

3.15.1
rectangular robot
cartesian robot
robot (2.6) whose **arm** (3.2) has three **prismatic joints** (3.7.1), whose axes are coincident with a Cartesian coordinate system

EXAMPLE — Gantry robot (see figure A.1)

3.15.2
cylindrical robot
robot (2.6) whose **arm** (3.2) has at least one **rotary** (3.7.2) and at least one **prismatic joint** (3.7.1) and whose axes form a cylindrical coordinate system

NOTE — See figure A.2.

3.15.3
polar robot
spherical robot
robot (2.6) whose arm has two **rotary joints** (3.7.2) and one **prismatic joint** (3.7.1) and whose axes form a polar coordinate system

NOTE — See figure A.3.

3.15.4
pendular robot
polar robot (3.15.3) whose mechanical structure includes a universal joint pivoting subassembly.

NOTE — See figure A.4.

3.15.5
anthropomorphic robot
articulated robot
robot (2.6) whose **arm** (3.2) has three **rotary joints** (3.7.2)

NOTE — See figure A.5.

3.15.6
SCARA robot
robot (2.6) which has two parallel **rotary joints** (3.7.2) to provide **compliance** (5.3.7) in a selected plane

NOTE — SCARA derives from Selectively Compliant Arm for Robotic Assembly.

3.15.7
spine robot
robot (2.6) whose **arm** (3.2) is made up of two or

more **spherical joints** (3.7.4)

3.15.8
parallel robot
robot (2.6) whose **arms** (3.2) (primary axes) have three concurrent **prismatic joints** (3.7.1)

4 Geometry and kinematics

4.1
forward kinematics
mathematical relationship which determines the **tool coordinate system** (4.7.5) based on the values of the joint coordinates

4.2
inverse kinematics
mathematical relationship which determines the values of the joint coordinates based on the values of the **tool coordinate system** (4.7.5)

4.3
axis
direction used to specify the **robot** (2.6) motion in a linear or rotary mode

NOTE — Axis is also used with the meaning of robot mechanical joint.

4.4
degree of freedom
DOF
one of the variables (maximum number of six) required to define the motion of a body in space

NOTE — Because of possible confusion with **axes** (4.3) it is advised not to use the term "degree of freedom" for describing the motion of the robot.

4.5
pose
combination of position and orientation in space

4.5.1
command pose
programmed pose
pose (4.5) specified by the **task program** (5.1.1)

4.5.2
attained pose
pose (4.5) achieved by the **robot** (2.6) in response to the **command pose** (4.5.1)

4.5.3
alignment pose
specified **pose** (4.5) used to establish a geometrical reference for the **robot** (2.6)

4.5.4
path
ordered set of **poses** (4.5)

4.6
trajectory
path (4.5.4) in time

4.7
Coordinate systems
See ISO 9787:1990, *Manipulating industrial robots — Coordinate systems and motions.*

4.7.1
world coordinate system
stationary coordinate system referenced to earth which is independent of the **robot** (2.6) motion

4.7.2
base coordinate system
coordinate system referenced to the **base mounting surface** (3.9)

4.7.3
mechanical interface coordinate system
coordinate system referenced to the **mechanical interface** (3.10)

4.7.4
joint coordinate system
coordinate system referenced to the joint axes, the joint coordinates of which are defined relative to the preceding joint coordinates or to some other coordinate system

4.7.5
tool coordinate system
TCS
coordinate system referenced to the tool or to the **end effector** (3.11) attached to the **mechanical interface** (3.10)

4.8 Spaces

4.8.1
maximum space
space which can be swept by the moving parts of the **robot** (2.6) as defined by the manufacturer plus the space which can be swept by the **end effector** (3.11) and the workpiece

4.8.2
restricted space
portion of the **maximum space** (4.8.1) that is

restricted by limiting devices that establish limits that will not be exceeded in the event of any foreseeable failure of the **robot system** (2.14)

NOTE — The maximum distance that the robot can travel after the limiting device is actuated is considered the basis for defining the restricted space.

4.8.3
operational space
portion of the **restricted space** (4.8.2) that is actually used while performing all motions commanded by the **task program** (5.1.1)

4.8.4
working space
space which can be swept by the wrist reference point (4.10) added by the range of rotation or translation of each joint in the **wrist** (3.3)

NOTE — The working space is smaller than the space which can be swept by all the moving parts of the **manipulator** (2.1)

4.9
tool centre point
TCP
point defined for a given application with regard to the **mechanical interface coordinate system** (4.7.3)

4.10
wrist reference point
intersection point of the two innermost **secondary axes** (3.3) (i.e. those closest to the primary axes), or, if this does not exist, a specified point on the innermost secondary axis

4.11
coordinate transformation
process of changing the coordinates of a **pose** (4.5) from one **coordinate system** (4.7) to another

5 Programming and control

5.1 Programs

5.1.1
task program
set of instructions for motion and auxiliary functions that define the specific intended task of the **robot system** (2.14)

NOTES

1 This type of program is normally generated by the user.

2 An application is a general area of work; a task is specific within the application.

5.1.2
control program
inherent set of control instructions which defines the capabilities, actions, and responses of a **robot system** (2.14)

NOTE — This type of program is fixed and usually not modified by the user.

5.2 Programming

5.2.1
task programming
programming
act of providing the **task program** (5.1.1)

5.2.2
manual data input programming
program generation and entry directly into the robot **control system** (2.7) by means of switches or plugboards or keyboards

5.2.3
teach programming
programming performed by

— manually leading the robot **end effector** (3.11);
— manually leading a mechanical simulating device; or
— using a **teach pendant** (5.8) to move the **robot** (2.6) through the desired actions

5.2.4
off-line programming
programming method where the **task program** (5.1.1) is defined on devices separate from the **robot** (2.6) for later entry to the robot

5.2.5
goal directed programming
programming method in which the task to be carried out is defined but the **path** (4.5.4) of the **end effector** (3.11) is not prescribed

5.3 Control

5.3.1
pose-to-pose control
control procedure whereby the user can only impose to the **robot** (2.6) to pass by the **command poses** (4.5.1) without fixing the **path** (4.5.4) to be followed between the poses

5.3.2
continuous path control
control procedure whereby the user can impose to the **robot** (2.6) the **path** (4.5.4) to be followed between **command poses** (4.5.1) at a programmed velocity

5.3.3
sensory control
control scheme whereby the **robot** (2.6) motion or force is adjusted in accordance with outputs of external sensors.

5.3.4
adaptive control
control scheme whereby the control system parameters are adjusted from conditions detected during the process

5.3.5
learning control
control scheme whereby the experience obtained during previous **cycles** (6.22) is automatically used to change control parameters and/or algorithms.

5.3.6
motion planning
process by which the **robot** (2.6) control program determines how to move the joints of the mechanical structure between the **poses** (4.5.1) programmed by the user, according to the type of interpolation chosen

5.3.7
compliance
flexible behaviour of a **robot** (2.6) or any associated tool in response to external forces exerted on it

NOTE — When the behaviour is independent of sensory feedback, it is passive compliance; if not, it is active compliance.

5.3.8
operating mode
state of the robot **control system** (2.7)

5.3.8.1
automatic mode
operating mode (5.3.8) in which the **robot control system** (2.7) operates in accordance with the **task program** (5.1.1)

5.3.8.2
manual mode
operating mode (5.3.8) in which the robot (2.6) can be operated by, for example, pushbutton or joystick and that excludes automatic operation

5.4
servo control
process by which the robot **control system** (2.7) checks if the **attained pose** (4.5.2) corresponds to the **pose** (4.5) specified by the **motion planning** (5.3.6) with required performance and safety criteria

5.5
normal operating state
automatic operation
state in which the **robot** (2.6) is executing its **task program** (5.1.1) as intended

5.6
stop-point
command pose (4.5.1) (taught or programmed) which shall be attained by the axes of the **robot** (2.6) with a velocity command equal to zero and no deviation in positioning

5.7
fly-by point
command pose (4.5.1) (taught or programmed) that the axes of the **robot** (2.6) will attain with some deviation, the amount of which depends on the joining profile of the axis velocity to this **pose** (4.5) and a specified criterion of passage (velocity, deviation in position)

5.8
pendant
teach pendant
hand-held unit linked to the **control system** (2.7) with which a robot (2.6) can be programmed or moved

5.9
joystick
manually controlled device whose variable positions and orientations or applied forces are measured and result in commands to the robot **control system** (2.7)

6 Performance

6.1
normal operating conditions
range of environmental conditions (for example temperature, humidity) and other parameters which may influence robot performance (such as electrical supply instability, electromagnetic

fields) within which the performance of the **robot** (2.6) specified by the manufacturer is valid.

6.2 Loads

6.2.1
load
force and/or torque at the **mechanical interface** (3.10) which can be exerted along the various directions of motion under specified conditions of velocity and acceleration

NOTE — The load is a function of mass, moment of inertia. and static and dynamic forces supported by the **robot** (2.6).

6.2.2
rated load
maximum **load** (6.2.1) that can be applied to the **mechanical interface** (3.10) in **normal operating conditions** (6.1) without degradation of any performance specification

NOTE — The rated load includes the inertial effects of the **end effector** (3.11), accessories and workpiece where applicable.

6.2.3
limiting load
maximum **load** (6.2.1) stated by the manufacturer which can be applied to the **mechanical interface** (3.10) without any damage or failure to the **robot** (2.6) mechanism under restricted operating conditions

6.2.4
additional load
additional mass
load (6.2.1) that can be carried by the **robot** (2.6), in addition to the **rated load** (6.2.2), and not applied at the **mechanical interface** (3.10) but somewhere else on the articulated structure [generally, on the **arm** (3.2)]

6.2.5
maximum thrust
thrust that can be continuously applied to the **mechanical interface** (3.10), excluding any inertial effect, assuring no permanent damage to the **robot** (2.6) mechanism

6.2.6
maximum moment
maximum torque
moment (torque) that can be continuously applied to the **mechanical interface** (3.10), excluding any inertial effect, assuring no permanent damage to the **robot** (2.6) mechanism

6.3 Velocity

6.3.1
individual joint velocity
individual axis velocity
velocity of a specified point resulting from the movement of one individual joint

6.3.2
path velocity
change of position [**pose** (4.5)] per unit time along the **path** (4.5.4)

6.4 Acceleration

6.4.1
individual joint acceleration
individual axis acceleration
acceleration of a specified point resulting from the movement of one individual joint

6.4.2
path acceleration
change of velocity per unit time along the **path** (4.5.4)

6.5
pose accuracy
unidirectional pose accuracy
difference between a **command pose** (4.5.1) and the mean of the **attained poses** (4.5.2) when visiting the command pose from the same direction

6.6
pose repeatability
unidirectional pose repeatability
closeness of agreement among the **attained poses** (4.5.2) for the same **command pose** (4.5.1) repeated from the same direction

6.7
multidirectional pose accuracy variation
maximum distance between the mean **attained poses** (4.5.2) achieved when visiting the same **command pose** (4.5.1) multiple times from three perpendicular directions

6.8
distance accuracy
difference between a command distance and the mean of the attained distances

6.9
distance repeatability
closeness of agreement among the attained

distances for the same command distance repeated in the same direction

6.10
pose stabilization time
period of time which elapses between the instant at which the **robot** (2.6) gives the "in position" signal and the instant at which the damped oscillatory motion or the damped motion of the **mechanical interface** (3.10) is within a specified limit

6.11
pose overshoot
maximum distance between the approach (command) path and the **attained pose** (4.5.2) after the robot (2.6) has given the "in position" signal

6.12
drift of pose accuracy
variation of **pose accuracy** (6.5) over a specified time

6.13
drift of pose repeatability
variation of **pose repeatability** (6.6) over a specified time

6.14
path accuracy
difference between the command **path** (4.5.4) and the mean of the attained paths

6.15
path repeatability
closeness of the agreement between multiple attained **paths** (4.5.4) for the same command path

6.16
path velocity accuracy
difference between a command **path velocity** (6.3.2) and the mean of the attained path velocity when traversing a command path

6.17
path velocity repeatability
closeness of agreement of the velocities attained for a given command **path velocity** (6.3.2)

6.18
path velocity fluctuation
difference between the minimum and maximum velocities which results from traversing a given command **path** (4.5.4) with a given command velocity

6.19
minimum posing time
minimum time elapsed between departure from and arrival at the **mechanical interface** (3.10) stationary state when traversing a predetermined distance (including stabilization time)

6.20
static compliance
maximum amount of displacement per unit of **load** (6.2.1) applied to the **mechanical interface** (3.10)

6.21
resolution
smallest increment of movement that can be attained by each **axis** (4.3) or joint of the **robot** (2.6)

6.22
cycle
single execution of a **task program** (5.1.1)

6.23
cycle time
time required to perform the **cycle** (6.22)

6.24
standard cycle
sequence of movements by a **robot** (2.6) during a typical task (regarded as reference) under specified conditions

Annex A
(informative)

Examples of types of mechanical structure

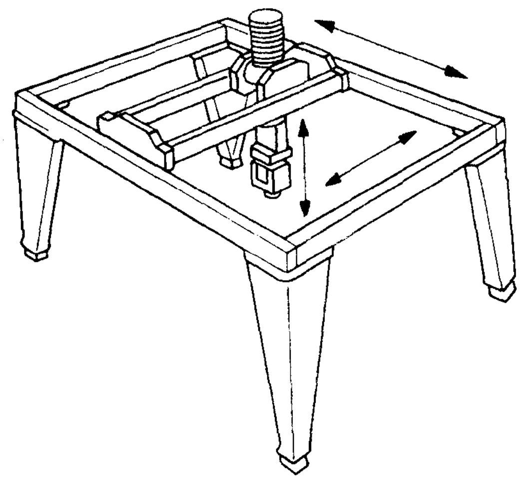

Figure A.1 — Rectangular or cartesian robot: gantry robot

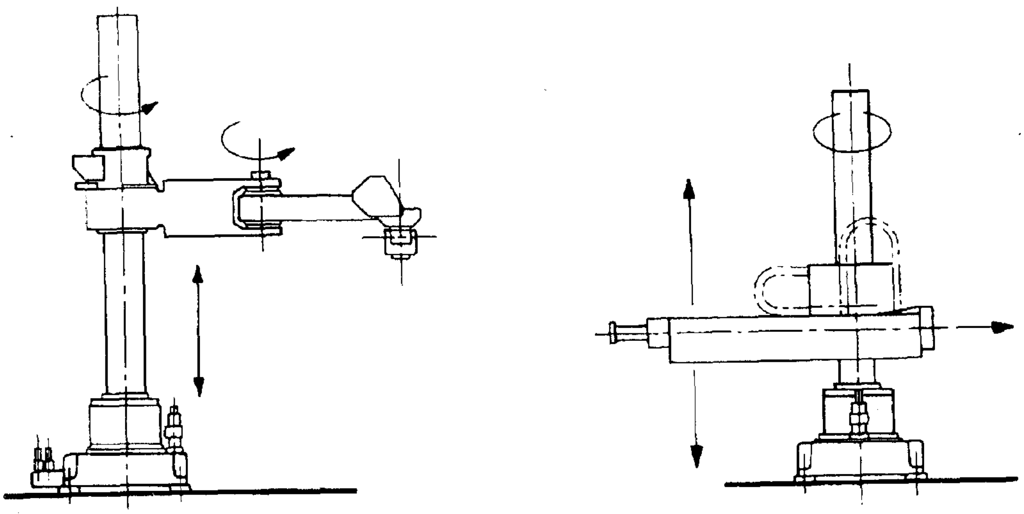

Figure A.2 — Cylindrical robot

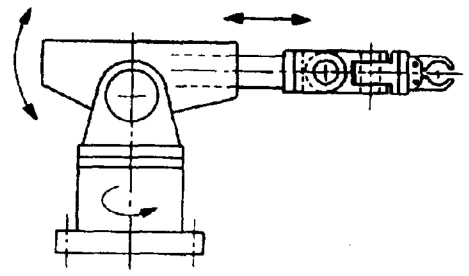

Figure A.3 — Polar (spherical) robot

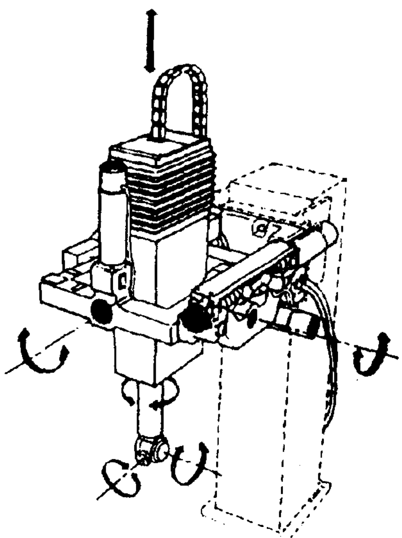

Figure A.4 — Pendular robot

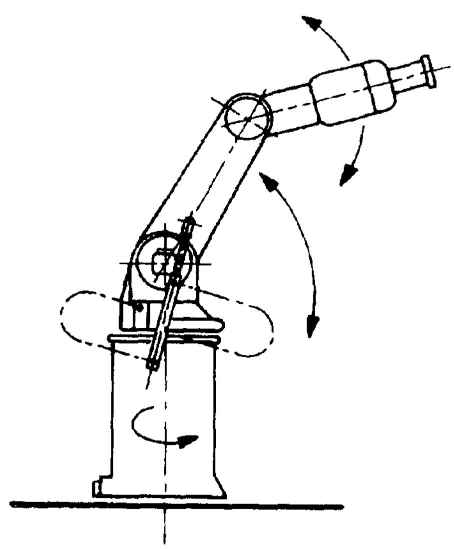

Figure A.5 — Anthropomorphic (articulated) robot

Alphabetical Index

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BIS is a statutory institution established under the *Bureau of Indian Standards Act*, 1986 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Handbook' and 'Standards Monthly Additions'

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